

## Remarks

### I. Status of claims

Claims 1-20 were pending.

Claims 21 and 22 have been added.

The Examiner has indicated that claim 12 would be allowable if rewritten in independent form.

### II. Claim rejections under 35 U.S.C. § 103 - Part 1

The Examiner has rejected claims 1-8, 10, 11, and 13-20 under 35 U.S.C. § 103(a) over Ackley (U.S. 5,265,596) in view of Hu (U.S. 6,658,040).

#### A. Independent claim 1

Independent claim 1 recites that "the longitudinal stack structure further includes an ion-implanted current confinement region characterized by a peak longitudinal implant concentration separated from the cavity region by a longitudinal distance greater than 0.5  $\mu\text{m}$ ."

In the rejection of claim 1, the Examiner has taken the position that the Buried Be Implant region 27 shown in FIG. 1 of Ackley corresponds to the ion-implanted current confinement region recited in claim 1. The Examiner has acknowledged that Ackley does not teach anything that would have led one skilled in the art to place the peak longitudinal implant concentration of the implant region 27 separated from a cavity region, which includes an active light generation region and a cavity extension region, by a longitudinal distance greater than 0.5  $\mu\text{m}$ .

To make-up for this lack of disclosure in Ackley, the Examiner has relied on Hu. In particular, the Examiner has stated that the capacitance-reducing implant region 860 shown in FIGS. 8A and 8B of Hu is an ion-implanted current confinement region. In col. 15, lines 50-54, Hu discloses that the capacitance-reducing implantation region 860 is about 0.05-0.5 micrometers from the top of the isolatable layer 844. The Examiner has concluded from this disclosure that it would have been obvious to one skilled in the art to place the peak longitudinal implant concentration of the implant region 27 in Ackley separated from the cavity region by a longitudinal distance greater than 0.5  $\mu\text{m}$ .

The capacitance-reducing implantation region 860, however, does not function as a current confinement region. Instead, the capacitance-reducing implantation region 860 is a proton-implanted region “that is disposed relatively closer to the aperture 180 for reducing the parasitic capacitance without dramatically increasing the resistance” (col. 14, lines 64-67). The current confinement function in Hu’s VCSEL is performed by “a single isolatable layer 844 for defining an insulator-confined aperture 180 that is disposed in the second semiconductor mirror 830” (col. 14, lines 36-38). As explained in the context of the embodiment shown in FIG. 2, which contains an isolatable layer 188 that corresponds to and includes the same current confining aperture 180 as the isolatable layer 844 in the embodiment shown in FIG. 8A (col. 7, lines 48-52):

The current flow between electrodes 105 and 154 is confined to region 180 by an insulating region 240 produced by converting portions of the oxidizable layer 188 to an insulator as described below. The region 180 is referred to as a current confining aperture.

Thus, the capacitance-reducing implantation region 860 cannot reasonably be considered to be a current confinement region. Accordingly, contrary to the Examiner’s assumption, one skilled in the art at the time the invention was made would not have looked to the position of Hu’s capacitance-reducing implantation region 860 for guidance as to where to position Ackley’s Buried Be Implant region 27. That is, one skilled in the art at the time the invention was made would not have been motivated to modify Ackley’s VCSEL in the manner proposed by the Examiner.

For at least these reasons, the Examiner’s rejection of independent claim 1 under 35 U.S.C. § 103(a) over Ackley in view of Hu should be withdrawn.

B. Claims 2-8, 10, 11, and 13

Each of claims 2-8, 10, 11, and 13 incorporates the features of independent claim 1 and therefore is patentable over Wang for at least the same reasons explained above. These claims also are patentable over Wang for the following additional reasons.

1. Claim 2

Claim 2 recites that the VCSEL includes “a metal contact disposed on the light emitting surface and defining an aperture, wherein the ion-implanted current confinement region defines a current aperture larger than the aperture of the metal contact.” The Examiner

has stated that Hu discloses this feature in FIG. 8A. In this rejection, however, the Examiner incorrectly has assumed that the capacitance-reducing implant region 860 defines the current aperture of HU VCSEL. As explained above, the aperture 180, which is defined by the isolatable layer 844, is the current aperture of Hu's VCSEL. FIG. 8A clearly shows that the current aperture 180 is smaller than the aperture of the metal contact 105. For at least this additional reason, the Examiner's rejection of claim 2 should be withdrawn.

## 2. Claim 3

Claim 3 recites that "both R1 and R2 are at least 99.5%." In the rejection of claim 3, the Examiner merely has stated that "it is believed that first and second mirrors with the bottom mirror greater than 99.9% and less than 99.7% for top and bottom mirrors are well known in the art ..." This statement, however, does not meet the claim language of claim 3.

Moreover, this "belief" by itself does not establish the requisite factual basis and the requisite motivation to support a *prima facie* case of obviousness (see MPEP § 706.02(j)). In particular, not only has the Examiner not established that the features of claim 3 are indeed "well known", the Examiner also has not explained why one skilled in the art would have been motivated to modify Ackley's VCSEL structure to arrive at the invention defined in claim 3. The Examiner simply has not pointed to any suggestion or motivation in Ackley, Hu, or in the knowledge generally available that would have led one skilled in the art at the time the invention was made to arrive at the VCSEL defined in claim 3.

For at least these reasons, the Examiner has not established a *prima facie* case of obviousness under 35 U.S.C. § 103 (see, e.g., MPEP § 706.02(j)), and the Examiner's rejection of claim 3 under 35 U.S.C. § 103(a) over Ackley, Hu, and the unspecified and unsubstantiated "well-known" prior art should be withdrawn for this additional reason.

## 3. Claim 4-8, 10, and 11

Claim 4 recites that "the cavity extension region has a longitudinal optical thickness greater than twice the operative wavelength."

Claim 5 recites that "the longitudinal optical thickness of the cavity extension region is less than about twenty times the operative wavelength."

Claim 6 recites that "the cavity region without the cavity extension region has a longitudinal optical thickness substantially equal to the operative wavelength."

In the rejection of claims 4-6, the Examiner has stated that:

With respect to claims 4-6, Hu ... does not explicitly disclose the thickness of the layer 844 (which is considered as cavity extension region) being equal to the thickness of the implanted region (col. 15, lines 54-59). However, Hu discloses the thickness (depth) of the implanted region being between 0.2-2  $\mu\text{m}$ . Therefore the thickness of the cavity extension is less than about twenty times the operating wavelength and greater twice the operative wavelength (see col. 18, lines 1-14 for operative wavelength). Hu further discloses DBR includes alternating layers of different refractive index materials each having a longitudinal optical thickness substantially equal to one-quarter of the operative wavelength (col. 7, lines 32-36).

Contrary to the Examiner's assumption, the isolatable layer 844 is not a cavity extension region. First, the isolatable layer 844 is not located in a cavity region that includes an active light generation region; instead, it is located in one or both of the mirror stacks (see, e.g., col. 6, lines 49-51). Second, the isolatable layer 844 corresponds to an oxidized (i.e., damaged) layer of the mirror stack in which it resides and, as is conventional, this layer typically has a thickness that is one quarter of the operating wavelength (see col. 7, lines 32-36).<sup>1</sup>

The Examiner simply has not pointed to any structure in either Ackley or Hu that corresponds to a cavity extension region that has the features defined in any of claims 4-6. For at least this additional reason, the Examiner's rejection of claims 4-6 under 35 U.S.C. § 103(a) over Ackley in view of Hu should be withdrawn.

Claim 7 incorporates the features of claim 6 and therefore is patentable over Ackley and Hu for at least the same additional reasons explained above.

Each of claims 8, 10, and 11 incorporates the features of claim 4 and therefore is patentable over Ackley and Hu for at least the same additional reasons explained above.

#### 4. Claim 13

Claim 13 recites that "the current confinement region defines a current aperture with a diameter of less than 12 micrometers."

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<sup>1</sup> It is noted that, contrary to the Examiner's assumption, the "depth" described to in col. 15, lines 54-59, of Hu refers to the depth of the pertinent region from the top surface of the VCSEL, not the thickness of the region. Indeed, FIG. 8A clearly shows that the thickness of the capacitance-reducing region 860 is not "about the same or shorter" than the thickness of the isolatable layer 844.

The Examiner has stated that Hu discloses this feature is col. 16, lines 19-24. This disclosure, however, merely teaches that in a traditional a mesa-type or pillar-type VCSEL design the etched mesa includes a diameter of about 10-30  $\mu\text{m}$ . In the remainder of the paragraph containing the disclosure cited by the Examiner, Hu explains that when the capacitance-reducing implantation region 860 is incorporated into such a structure the mesa diameter is enlarged "in order to maintain a lower differential resistance while reducing or controlling the parasitic oxide capacitance by using the capacitance-reducing implantation region 860" (col. 16, lines 32-34). Hu, however, does not teach or suggest the diameter size of the mesa in the mesa-type VCSELs that incorporate the capacitance-reducing implantation region 860, much less does he disclose the size of the current confining aperture 180 that is defined by the isolatable layer 844 in such VCSELs.

For at least these additional reasons, the Examiner's rejection of claim 13 under 35 U.S.C. § 103(a) over Ackley in view of Hu should be withdrawn.

C. Independent claims 14 and 15

Each of independent claims 14 and 15 recites features that essentially track the pertinent features discussed above in connection with independent claim 1 and, therefore, is patentable over Ackley and Hu for at least the same reasons.

D. Claims 16-20

Each of claims 16-20 incorporates the features of independent claim 15 therefore is patentable over Ackley and Hu for at least the same reasons explained above.

Claim 16 also is patentable over Ackley and Hu for the additional reasons explained above in connection with claim 2.

Claim 17 also is patentable over Ackley and Hu for the additional reasons explained above in connection with claims 4 and 5.

Claim 18 also is patentable over Ackley and Hu for the additional reasons explained above in connection with claim 6.

Claim 19 also is patentable over Ackley and Hu for the additional reasons explained above in connection with claim 8.

Claim 20 also is patentable over Ackley and Hu for the additional reasons explained above in connection with claim 4.

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Serial No. : 10/694,290  
Filed : March 17, 2000  
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Attorney's Docket No.: 10031055-1  
Amendment dated Sep. 5, 2006  
Reply to Office action dated June 7, 2006

III. Claim rejections under 35 U.S.C. § 103 - Part 2

The Examiner has rejected claims 1 and 9 under 35 U.S.C. § 103(a) over Ackley (U.S. 5,446,752) in view of Hu.

A. Independent claim 1

Ackley ('752), however, does not teach anything that would have led one skilled in the art to place the peak longitudinal implant concentration of the implant regions 65 separated from a cavity region, which includes an active light generation region and a cavity extension region, by a longitudinal distance greater than 0.5  $\mu\text{m}$ . Hu does not make-up for this lack of disclosure for the same reasons explained above in connection with the rejection of claim 1 over Ackley ('596) in view of Hu.

For at least these reasons, the Examiner's rejection of independent claim 1 under 35 U.S.C. § 103(a) over Ackley ('752) in view of Hu should be withdrawn.

B. Claim 9

Claim 9 incorporates the features of independent claim 1 and therefore is patentable over Ackley ('752) and Hu for at least the same reasons.

Claim 9 also is patentable over Ackley ('752) and Hu for at least the same additional reasons explained above in connection with claim 4.

IV. Conclusion

For the reasons explained above, all of the pending claims are now in condition for allowance and should be allowed.

Charge any excess fees or apply any credits to Deposit Account No. 50-3718.

Respectfully submitted,

Date: September 5, 2006



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